

Experimenting with MTG-IRS level 2 data assimilation into the ECMWF model



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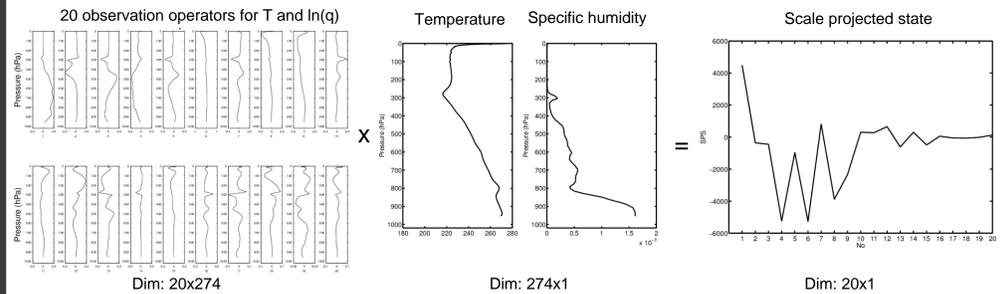
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Introduction

The Meteosat third generation (MTG) geostationary satellites will carry a hyper-spectral infrared sounder (MTG-IRS) instrument. EUMETSAT has developed a MTG-IRS level 2 (L2) processor to generate temperature, humidity and ozone retrievals for cloud free field of views. In this study observations from the IASI instrument on METOP-B are used as a proxy in the L2 processor. The processor uses ECMWF model information as prior information about the atmospheric state and error covariance. In the post-processing stage the temperature and humidity retrievals are transformed into scaled projected state (SPS) observations which according to the theory are independent of the prior information used in the retrieval process.

Scale projected state (SPS)

The post processing into SPS observations is based on theory presented in Migliorini (2012) which shows that under certain assumptions assimilation of a retrieval product is equivalent to direct assimilation of radiances.

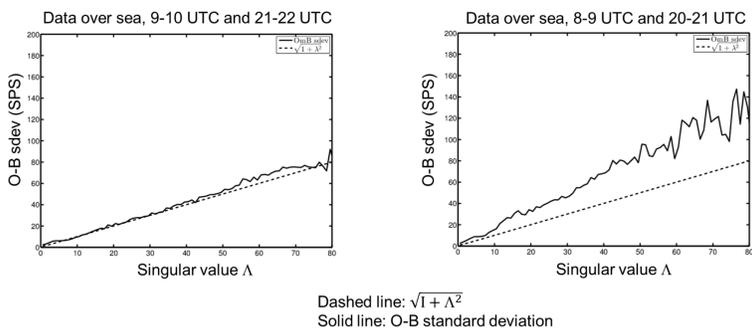


Passive monitoring

Results indicate very good agreement with the SPS innovation statistics and the theoretical values when good quality first guess is used (left panel).

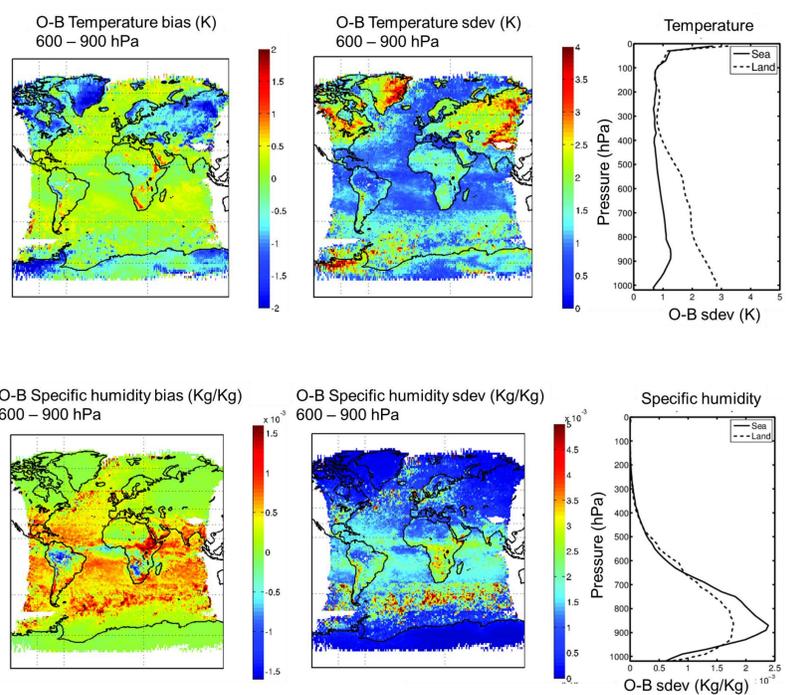
When lower quality first guess (11-12h off from the actual observation time) has been given too much weight in the retrieval process the resulting SPS innovation statistics are far from the expected theoretical model (right panel).

$$\sqrt{(y - Hxb)(y - Hxb)^T} = \sqrt{I + \Lambda^2}$$



Conclusions

- Consistent behaviour for T, q, SPS.
- Quality is better over sea than over land.
- Generally good quality when first guess valid close to observation time is used.
- Data quality degrades towards the end of the 12-hour period where the same first guess is used.
- Improvements expected when use of 1-hourly first guess is implemented to the L2 processor.



Single observation experiments

Cloud contamination

Solid black line:

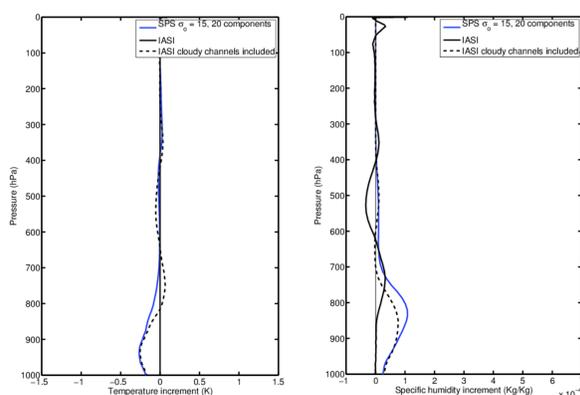
- IASI radiance assimilated as in operations. 72/188 channels rejected due to possible cloud contamination.

Dashed black line:

- IASI radiance assimilated, cloudy channels included

Solid blue line:

- SPS assimilated



Skin temperature

Solid black line:

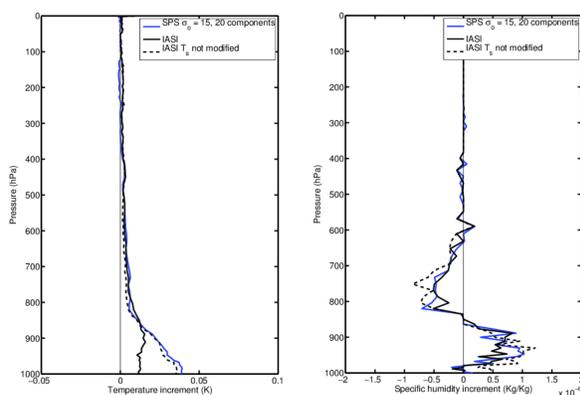
- IASI radiance assimilated as in operational setup. All channels cloud free.

Dashed black line:

- IASI radiance assimilated, T_{skin} sink variable not used.

Solid blue line:

- SPS assimilated



Conclusions

Assimilation of IASI radiances or SPS retrievals can create comparable analysis increments. However, in these examples differences arise from:

- Detecting remaining cloud contaminated SPS observations is a real challenge.
- SPS does not currently include T_{skin} which is used as sink variable in radiance assimilation.

Assimilation experiments

Experiments 1.8- 15.9.2016

CTL: conventional observations only

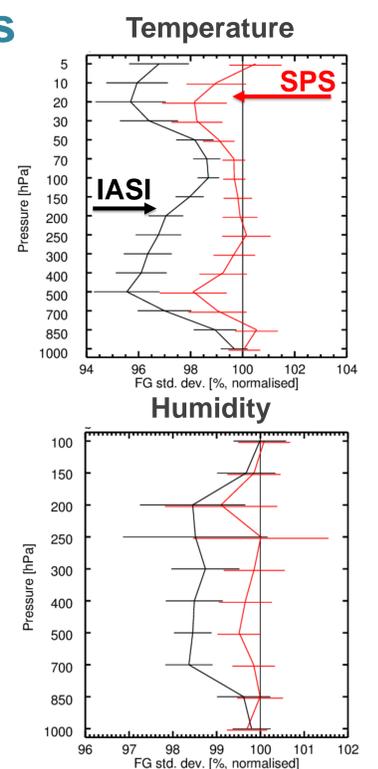
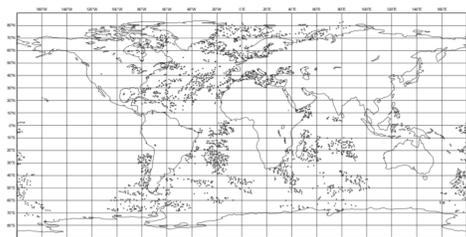
SPS: CTL + Metop-B SPS geo disc, over sea

- First guess check $y - Hx_b < 30$
- Horizontal thinning: 125 km
- Observation error 15

IASI: CTL + Metop-B IASI geo disc, over sea

- As in operations, relaxed first guess check but tight cloud screening.
- Horizontal thinning: 125 km

Sample coverage of SPS in 12-h DA window



Conclusions

Assimilation of IASI radiances has clear positive impact on short term T and q forecasts, while assimilation of SPS has neutral to slightly positive impact. It is likely that even with tight QC, cloud contaminated SPS observations are used in assimilation. Role of T_{skin} needs to be further investigated. Degrading observation quality towards the end of DA window is also suboptimal. EUMETSAT is currently implementing updated L2 processor and improved data quality is expected..

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References: Migliorini, S. (2012) On the equivalence between radiance and retrieval assimilation. Monthly Weather Review, 140 (1), pp. 258-265.